



Title: Tropospheric Ozone and Aerosols Measured by Airborne Lidar during the 1988 Arctic Boundary Layer Experiment

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Ozone (O_3) and aerosol distributions were measured from an aircraft using a differential absorption lidar (DIAL) system as part of the 1988 NASA Global Tropospheric Experiment--Arctic Boundary Layer Experiment (ABLE-3A) to study the sources and sinks of gases and aerosols over the tundra regions of Alaska during the summer. The airborne DIAL system made measurements of O_3 and aerosols above and below the NASA Wallops Electra aircraft to obtain data from the surface to above the tropopause. These measurements comprise the first extensive set of simultaneous nadir and zenith observations of tropospheric ozone and aerosols. They were made in a broad range of atmospheric conditions over the tundra, ice, and ocean regions near Barrow and Bethel, Alaska, from July 10 to August 12, 1988.

The tropospheric O_3 budget over the Arctic was found to be strongly influenced by stratospheric intrusions. Regions of low aerosol scattering and enhanced O_3 mixing ratios were usually correlated with descending air from the upper troposphere or lower stratosphere. In the vicinity of Barrow, Alaska, O_3 was generally in the range of 20-30 ppbv below 2 km; however, air with O_3 >40 ppbv and low aerosol scattering was found as low as 1 km with continuity in air mass characteristics to above 3 km. These increases could be followed back to large-scale stratospheric intrusions that affected the distribution of O_3 in the upper troposphere. Ozone mixing ratios of >100 ppbv were found as low as 6 km in the presence of strong intrusion events. The variability in O_3 in the mid to upper troposphere affects the O_3 distribution in the lower troposphere, and due to the frequency of the observed intrusions, this process plays an important role in the tropospheric O_3 budget at high latitudes.

Several cases of continental polar air masses were examined during this experiment. The aerosol scattering associated with these air masses was very low,



and the atmospheric distribution of aerosols was quite homogeneous for those air masses that had been transported over the ice for ≥ 3 days. The average O_3 profile derived from three cases of continental polar air masses had a nearly constant gradient of 7 ppbv/km from 30 ppbv at 600 m to 55 ppbv at 4 km. This distribution reflects the influence of downward transport of O_3 from the upper troposphere at high latitudes.

Five cases were studied to determine the average background O_3 profile over the tundra region of southwestern Alaska. Near the surface, the tundra and continental polar O_3 levels are about the same; however, the average O_3 value above 1.5 km is 10-20% less than for the continental polar cases. This is thought to be due to the influence of more frequent stratospheric intrusions at the higher latitudes associated with the continental polar air masses. Zenith O_3 profiles in the region of 56-62°N showed good agreement from 2.5-10.0 km in altitude with a 5.5 ppbv/km gradient determined below 2.5 over the tundra.

The transition in O_3 and aerosol distributions from tundra to marine conditions was examined on several occasions during this experiment. The aerosol data clearly show an abrupt change in aerosol scattering properties within the mixed layer from lower values over the tundra to generally higher values over the water. The distinct differences in the heights of the mixed layers in the two regions was also readily apparent. The O_3 distribution above 1 km, which is above the mixed layers over both regions, did not change along the transect; however, there was an apparent reduction of O_3 in the mixed layer over the tundra that was not present over the water. This is consistent with the tundra being more of a sink for O_3 than the water surface.

Several cases of enhanced O_3 were observed during ABLE-3A in conjunction with enhanced aerosol scattering in layers in the free troposphere. These layers were coming from regions where biomass burning was occurring. In some cases, the enhancement in O_3 was found to be more than 50% larger than the average background O_3 distribution over the tundra region. The products of biomass burning can significantly alter the O_3 concentrations in the troposphere in the Arctic as was shown to happen over the Amazon Basin during the dry season.

This poster presents examples of the large-scale variations of O_3 and aerosols observed with the airborne lidar system from near the surface to above the tropopause over the Arctic during ABLE-3A. These results are related to atmospheric dynamical and chemical processes that determine the distribution of O_3 and aerosols in the troposphere at high latitudes during the summer.